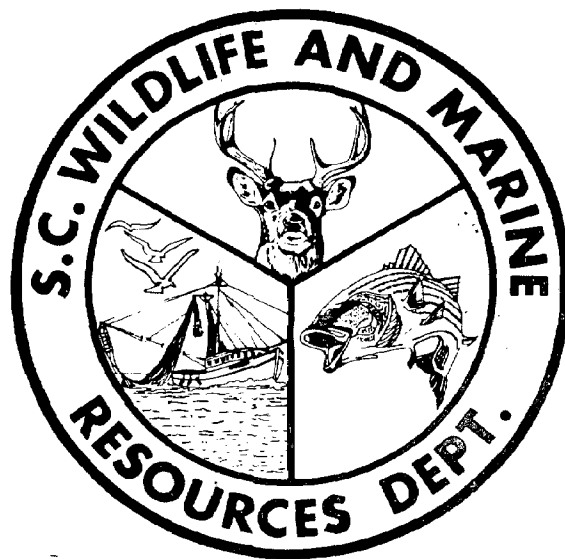
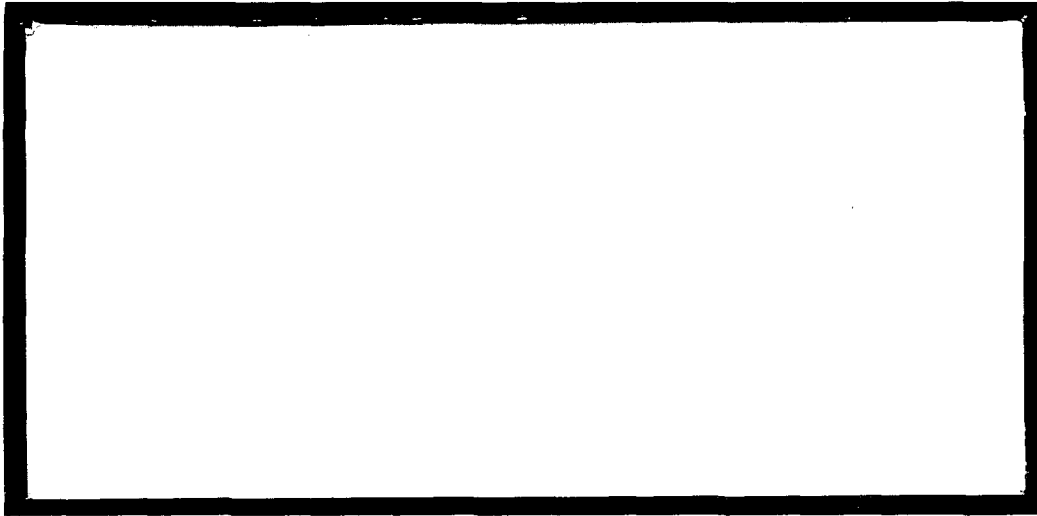


Coastal Zone  
Information  
Center

2 c



QH  
76.5  
.S6  
R63  
1983  
c2

SOUTH CAROLINA MARINE RESOURCES CENTER

South Carolina Marine Resources Center

Q476.5.56 R63 1983 C.2

A POLICY-PLAN FOR MITIGATION OF ALTERATIONS IN INSHORE AND  
OFFSHORE WETLANDS IN SOUTH CAROLINA, WITH SPECIAL REFERENCE  
TO OIL, GAS, AND MINERAL DEVELOPMENT.<sup>1</sup>

D. Nick Roark and D. E. Marchette

Environmental Evaluations Section  
Office of Conservation, Management and Marketing  
Marine Resources Division  
South Carolina Wildlife and Marine Resources Division  
Charleston, South Carolina 29412

August, 1983

<sup>1</sup>This work is the result of research sponsored by the Office of the Governor under Contract 065-05-80 by the South Carolina Wildlife and Marine Resources Department.

## Table of Contents

	Page
Title Page	i
Table of Contents	ii
Acronyms	iii
I. INTRODUCTION	1
A. Federal Statutes	2
B. State Statutes	5
II. CONCEPTS OF PROPOSED POLICY ON MITIGATION FOR SOUTH CAROLINA	8
A. Proposed Rules and Regulations	10
B. Agency Responsibility	13
III. GENERAL GUIDELINES FOR ACTIVITIES RELATED TO OIL, GAS AND MINERAL DEVELOPMENT AND PRODUCTION	14
A. Introduction	14
B. General Guidelines	17
C. General Stipulations for Inshore and OCS Activities	20
IV. SPECIFIC MITIGATIVE STRATEGIES	21
A. Mitigative Strategies for OCS Oil and Gas Related Activities	21
1. Impacts	21
2. Minimization of Environmental Impacts	21
3. Mitigation Alternatives	23
B. Mitigative Strategies for Inshore Oil and Gas Related Activities	23
1. Impacts	23
2. Minimization of Environmental Impacts	24
3. Mitigation Alternatives	26
C. Mitigative Strategies for OCS and Inshore Minerals Related Activities	29
1. Impacts	29
2. Minimization of Environmental Impacts	29
3. Mitigation Alternatives	31
V. References Cited	32

## Policy-Plan for Mitigation

### Acronyms

CCC	California Coastal Commission
DCNR	Department of Conservation and Natural Resources
DEM	Department of Environmental Management
DHEC	Department of Health and Environmental Control
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
FCZMA	Federal Coastal Zone Management Act of 1972
FWCA	Fish and Wildlife Coordination Act of 1934
FWPCA	Federal Water Pollution Control Act of 1977
MMS	Mineral Management Service
NEPA	National Environmental Policy Act of 1969
NMFS	National Marine Fisheries Service
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Land Act of 1953
RHA	Rivers and Harbors Act of 1899
SCCC	South Carolina Coastal Council
SCWMRD	South Carolina Wildlife and Marine Resources Department
SCWRC	South Carolina Water Resources Commission
SLA	Submerged Lands Act of 1953
USACOE	U. S. Army Corps of Engineers
USCG	U. S. Coast Guard
USFWS	U. S. Fish and Wildlife Service
USGS	U. S. Geological Survey

## I. INTRODUCTION

Significant losses of coastal wetlands and resources in South Carolina, due to excavation, filling, and impounding, and the potential disruption of Outer Continental Shelf (OCS) habitats as a result of OCS mineral and energy related activities have prompted the South Carolina Wildlife and Marine Resources Department (SCWMRD) to develop a policy-plan for mitigation. It is intended that the policy-plan will assist the regulatory agencies in making permitting and management certification decisions that involve wetland alterations requiring mitigation. The purpose of the plan is to provide guidelines for compensation of economic and natural resource benefits that are lost as a result of man-induced alteration of the state's wetlands. Compensation may come in the form of creation of wetland habitat from upland habitat or restoration and enhancement of marginally productive or otherwise stressed wetland areas to more productive systems. If creation, restoration, or enhancement are not practical or feasible then some other effective, biologically sound compensation for lost economic and natural resource benefits should be implemented.

Coastal wetlands and offshore habitats provide many biological benefits and resources that must be protected. Wetlands are important for economic development that may or may not be resource related, and support a variety of economic activities that benefit the surrounding population. Water dependent projects as well as non-resource oriented public interest projects have a tremendous influence on the economics of South Carolina coastal communities and the state. Additionally, incremental destruction of wetland areas leads to incremental economic losses in industries that depend directly or indirectly on wetland related resources.

The concept of public usage of shores, public ownership of wetlands, and the compensation of lost biological and aquatic resources provided by a wetland is not new. The "Public trust doctrine" (the biological and aquatic resources that are provided by a wetland are public property, and use or destruction of these resources by any person or entity requires compensation to the public), was

first set forth by the Romans in 530 A.D. after being in general use for 400 years. In fact, this concept, Jus Gentium ("international law"), is almost 2,000 years old and public ownership of shorelands and related habitats has been defended in Roman, French, Spanish, English and American courts (Smith, 1983).

The concept of mitigation is used widely throughout the United States; however, a lack of firm policy guidance has often resulted in misunderstanding and misapplication of the concept. Various government entities have adopted vague statements of purpose regarding mitigation such as minimizing or reducing environmental impacts. The reduction of environmental damage is obviously important in the permitting process but does not adequately address the actual concept of mitigation. Objectives such as these tend to invite abuse of administrative discretion in planning mitigation. Therefore, the definition, purpose, and objectives of mitigation are extremely important in effectively implementing this concept. Existing definitions and interpretation of this concept are widely variable and have in general complicated the process of implementing mitigation through interagency cooperation and coordination.

Within the context of this document, the definition of mitigation is compensation to be afforded in the form of creation, restoration, or enhancement of wetland habitats, or other compensatory measures to offset unavoidable habitat loss associated with water dependent projects that demonstrate a significant public interest.

#### A. Federal Statutes

Mitigation, as implied for fish and wildlife management, first appears in the Fish and Wildlife Coordination Act (FWCA) of 1934 (16 USC, Sect. 661, et seq.). Initially, a technique of implementation was not available, and not until 1946 and 1958 did substantial amendments transform the FWCA into a Federal statute dealing with fish and wildlife mitigation (Krulitz, 1979). This Act requires that fish and wildlife conservation be given equal consideration with other features of Federal or federally sponsored or federally authorized projects.

Additionally, the FWCA contains a directive that project plans "shall contain mitigation measures deemed justifiable by the construction or licensing agency" (16 USC, Sect. 662 (b)). Furthermore, the FWCA indicates that both pre and post authorization planning, including mitigation, must be coordinated with the U.S. Fish and Wildlife Service (USFWS) and the concerned state fish and wildlife agencies (16 USC, Sect. 662 (a)). The USFWS and the state fish and wildlife agency must prepare a detailed "fish and wildlife report" which identifies the ecology, impacts and uses, and proposes mitigation for fish and wildlife resource losses (16 USC, Sect. 662 (b)). However, because the FWCA does not indicate where the burden of proof is to be placed and resource agencies are basically required to convince the constructing agency of the justifiability of mitigation, it cannot by itself provide the authority necessary to effectively implement the concept (Ashe, 1982).

The National Environmental Policy Act (NEPA) of 1969 (42 USC, Sect. 4321, et seq.) provisions apply to all Federal agencies and activities involving Federal monies and require that during project planning and implementation:

1. all practicable measures for mitigation are studied;
2. that these measures are included and reviewed in the environmental impact statement process;
3. that the plans for mitigation agreed upon are carried out and effectively monitored by the lead agency.

NEPA has provided the regulation necessary to integrate fish and wildlife mitigation with the overall planning process, in addition to requiring that all practicable mitigation be undertaken by the lead agency. Nonetheless, even with the complementary authorities of the FWCA and NEPA, there exists no specific requirement that effective mitigation occur, but only that the constructing agency explain any decision to forego mitigation (Brunner, 1980). This is an extremely important factor and has severely limited the implementation of credible mitigation. Obviously, there is a significant difference between an authority to mitigate and a requirement to mitigate (Ashe, 1982).

The U.S. Army Corps of Engineers (USACOE), as a permitting agency, may be one of the most potentially effective entities for requiring and implementing mitigation in relation to privately funded projects (Ashe, 1982). Regulation by the USACOE is in the form of a permitting process required for all construction and excavation in navigable waters of the United States. This regulatory program has developed as a result of the Rivers and Harbors Act (RHA) of 1899 and the Federal Water Pollution Control Act (FWPCA) as amended in 1977. Under Section 10 of the RHA, Congress made unlawful any construction within navigable waters, without authorization from the Secretary of the Army (Power, 1973). Section 404 of the FWPCA has authorized the administrator of the Environmental Protection Agency (EPA) through the USACOE, to regulate the discharge of dredged or fill material into waters of the United States. The combined authority of these two acts allows the USACOE to regulate construction within all waters that Congress may regulate, including any activity which may affect the course, condition, or capacity of said waters (Banner, 1979). Section 404 guidelines created by EPA and administered by the USACOE state that "projects that fail to mitigate damage to fish and wildlife resources will generally not be permitted" (33 CFR, Sec. 209-120(9)(i)(6), 4(i), 5(i)). Additionally, USACOE regulations allow them to reject a permit application on environmental grounds. This is extremely important in that the FWCA and NEPA state that USACOE environmental decisions must undergo Federal and state review.

The USFWS has the responsibility of reviewing proposed wetland alteration projects and recommending mitigative conditions where appropriate. Consequently, the USFWS has developed a policy for mitigation to add credibility to their recommendations. The USFWS mitigative policy focuses on five generalized resource categories that must meet designation criteria. These criteria define "important species" and "habitat value," and utilize this concept to prioritize high monetary valued species and difficult-to-define "critical indicator species." Mitigative strategies are therefore more



responsive to high monetary valued species and habitats, resulting in resource value trade-offs. This policy, that emphasizes the loss of recognized, high priority resources, is designed around comprehensive, generic definitions, and vague statements of purpose. Due to its environmentally and ecologically restrictive nature, the USFWS policy will be ineffective in meeting long-term resource management objectives as developmental impacts are only reduced or offset (Ashe, 1982).

State agencies play a significant role in the Federal regulatory process. The Federal Coastal Zone Management Act (FCZMA) of 1972, as amended 1976, mandates (according to present administration interpretation) that Federal permitting activities must be consistent to the maximum extent practicable with established state coastal zone management plans. This is a policy and not a regulation but it encourages the USACOE to adhere to recommendations of the state agency having the regulatory responsibility for the state's coastal zone management plan. Thus, the presence of mitigative policy at the state level can profoundly alter the effectiveness of Federal permit mitigation.

#### B. State Statutes

Only California and Oregon have clear policies of mitigation that have evolved as a refinement of their federally approved coastal zone management plan. Although other coastal states utilize mitigation to offset wetland losses, only California and Oregon require mitigation as a functional segment of the permitting process.

The California Coastal Act of 1976 (Section 30233(c)) requires that diking, filling, or dredging of a wetland or estuary must be mitigated such that the functional capacity of the wetland or estuary is maintained. The Coastal Act is the basis or policy foundation for the California Coastal Commission (CCC). Under California law, permits for coastal development must be received from three regulatory entities, USACOE, CCC, and the local government having jurisdiction over the impacted area. If the local government does not recommend a more stringent mitigative strategy, the CCC will incorporate their mitigation plan into the state permit conditions.

The Oregon policy for mitigation (Oregon House Bill 2619) is specific to intertidal and wetland dredge and fill operations, and defines mitigation as "an activity which, when considered in conjunction with the negative impacts of an alteration, results in no net loss of estuarine values" (Ashe, 1982). The replacement of natural productivity by ecosystem maintenance or creation, thus encouraging value for value exchanges in contrast to acre-for-acre tradeoffs, is emphasized.

Oregon has developed classification rules which outline the coastal areas of the state where development can occur. These classification rules, in addition to mitigative requirements, are designated by the Oregon Coastal Zone Management Plan. The developer initiates the mitigative strategy in the application and has the responsibility of assuring that mitigation is consistent with the classification rules and the administrative rules for estuarine mitigation. The Oregon Division of State Lands, Oregon Department of Fish and Wildlife, Department of Land Conservation, local jurisdiction, and appropriate Federal agencies provide review and comments on permit applications.

Louisiana, Florida, Rhode Island, North Carolina and South Carolina utilize their existing coastal zone management plans and coastal legislation to implement mitigation (in lieu of a formal policy of mitigation). However, no states other than Oregon and California have provisions set forth with the sole intent of requiring either the developer, Federal agencies, or state agencies to initiate and enforce strategies for mitigation.

The Coastal Management Section of the Louisiana Department of Natural Resources acts as the regulatory permitting agency for all coastal development in Louisiana and will generally introduce mitigation into the permit application if the developer has not already done so. This is a joint permit review process with USACOE and fully utilizes state and Federal environmental agencies as well as the parish or local government as commenting entities (Lindsey, pers. comm.).

Florida utilizes a joint permitting system with the USACOE acting as the lead Federal agency and the Florida Department of Environmental Regulation as the lead regulatory agency for the state. If state lands are to be developed, a second state agency, Division of State Lands, must approve the permit application. Several additional state and Federal environmental agencies review and comment on all coastal permit applications. Generally, the USFWS will recommend, if appropriate, mitigation in the form of some conservation easement with certain environmental stipulations and projects for creating habitats. This is most often done by using the "elevation clause" in their comments and recommendations provided in the review of the USACOE permit (Setchfield, pers. comm.).

Florida has several systems of trust funds designed for conservation oriented land acquisition. However, only one of these actually simulates a form of mitigation or compensation for lost and/or impacted resources. Section 211.3103 of the Florida Statutes (tax on severance and production of minerals) establishes that 50 percent of the severance tax imposed on the oil and gas industry and the phosphate mining industry will be reserved for environmentally appropriate land acquisition and conservation. The Governor's cabinet, in addition to representatives from all state environmental agencies, makes up the committee responsible for administering these funds (Setchfield, pers. comm.).

North Carolina, South Carolina and Rhode Island have very similar permitting systems. A joint permitting process has evolved with the USACOE and an elected or appointed Coastal Council (in South Carolina and Rhode Island) or Coastal Commission (in North Carolina) sharing the permitting responsibility. No provisions have been established to provide an effective and consistent vehicle for the implementation of mitigation. Rarely will the USACOE stipulate mitigation in the permit application, requiring instead state or Federal review agencies to take the initiative.

## II. CONCEPTS OF PROPOSED POLICY ON MITIGATION FOR SOUTH CAROLINA

The issue of the policy in South Carolina is not that losses of fish and wildlife habitat should be mitigated; rather it is the determination of the kind and quantity of mitigation appropriate. The justification and necessity for mitigation is directly related to the unavoidable impacts associated with projects that are dependent on water, many of which are in the public interest. Proposed projects that would result in significant individual or cumulative adverse impacts on coastal wetlands and associated resources and those which are water dependent and in the public interest will be candidates for mitigation. Proposed projects that are non-water dependent, or that are not in the public interest, or that would lead to significant adverse impacts should not be allowed.

The general policy would emphasize an ecosystem approach to mitigation. Management for individual species or for individual resources is less useful than managing complete ecosystems. In support of the ecosystem approach, Ashe (1982) states that:

"This concept emphasizes the relationships and interactions between the living and non-living components of the system, emphasizing the pathways of energy and material flow between the individual components. Based on the ecosystem concept, fish and wildlife mitigation recognizes that an ecosystem can be equally responsive to both destruction and constructive alteration and that human activity may fit, compatibly, into the natural environment through coordinated natural resource planning which emphasizes the functional role of the altered habitat in overall system function. Thus, the concept of the ecosystem provides the most appropriate and defensible conceptual foundation for the use of mitigation as a positive management strategy."

Ideally, the policy in South Carolina should have a no-loss of habitat approach, while remaining flexible enough to provide effective alternative guidelines for mitigation, minimizing functional losses occurring in the wake of truly necessary alterations.

Traditional acre-for-acre tradeoffs and resource mitigation have been intensively questioned in South Carolina by many agencies involved with maintaining environmental quality. Although mitigation has been utilized extensively (creation of habitats, enhancement and restoration of habitats and water quality, and enhancement of fisheries programs, etc.) many negative factors have influenced the effectiveness of past attempts at mitigation.

1. Restrictive Scope of Mitigation Potential. The majority of regulatory power is restricted to inshore-onshore habitat; however, offshore development and particularly OCS activities have the potential to create economic growth and subsequent environmental perturbations. It is absolutely necessary to develop a policy at the state level for creating, restoring or enhancing habitat or compensating for environmental losses resulting from the exploration and recovery of minerals and petroleum products on the OCS.
2. Inconsistent and Arbitrary Mitigation. Presently, mitigation is required of some impacting projects. Generally, the smaller impacting projects are the most likely to have mitigative stipulations as part of a permit issuance while larger projects go unmitigated. Larger projects are often subsidized with state or Federal monies and may be rated high in public benefit, making it difficult to justify extra expenditures on mitigation.
3. Inconsistent Techniques of Mitigation. The framework for the selection of various techniques of mitigation with similar impacting projects (dredge and fill) has resulted in confusion and a lack of consistency. In addition, the concept of mitigation is inconsistently used, emphasizing resource values on some projects and ecological values on other projects.

4. Lack of Compliance. At this time there is no well defined policy in South Carolina designating authority for mitigation, making enforcement of mitigation difficult.
5. Limited Alternative Strategies. Although this document advocates a no-loss of wetland habitats and resources, the policy for mitigation must be flexible enough to provide effective alternative mitigation strategies so as to minimize biological and functional losses but not eliminate alterations that are absolutely necessary in the public interest.

The following sections of this document describe the proposed policy for mitigating alternations of wetlands in South Carolina. The intent of this proposed policy is to enhance the existing framework of the joint permitting process by providing a firm, well-planned program for the implementation of options existing for mitigation. The purpose of this program is to avoid a net loss of habitat by consideration of alternative strategies to create wetland habitat, restore and enhance impacted wetlands, or compensate for unavoidable alterations that adversely affect coastal wetlands, offshore bottoms and associated resources.

A. Proposed Rules and Regulations

Eligibility for the program of mitigation of wetlands will be determined through the normal joint process for reviewing permit applications. However, state environmental agencies may require mitigation as a condition of any permit influencing wetlands and shall require mitigation for all dredge and fill operations. It will be the responsibility of state environmental agencies to recommend, if appropriate, mitigation in the form of conditions or stipulations to be set forth in recommendations for permit applications. The conditions of mitigation as set forth in the recommendations will be received by the permitting authorities (South Carolina Coastal Council (SCCC)), South Carolina Department of Health and Environmental Control (DHEC), South Carolina Water Resources Commission (SCWRC), and USACOE).

Notwithstanding any provisions that are set forth in the statewide planning goals and in the guidelines set forth by the SCWMRD, SCWRC, DHEC and SCCC, the agencies may waive mitigation in part or in whole for an activity for which mitigation would otherwise be required if, after consultation with appropriate state and local agencies, it is determined that the activity is:

1. filling for repair and maintenance of existing functional dikes and/or water-control structures and as a result there will be negligible physical or biological damage to wetlands;
2. riprapping to allow protection of an existing shoreline with environmentally clean, erosion resistant material when the need for riprapping is fully demonstrated and when it is demonstrated that stabilization by vegetation is not comparable with protection by riprap and that no appreciable increase in existing upland will occur;
3. filling for repair and maintenance of existing roads resulting in negligible physical or biological damage to wetlands;
4. dredging for existing authorized navigation channels, jetties, or installation of navigational aids;
5. dredging or filling required as part of a wetlands restoration or enhancement project agreed to by local, state and Federal agencies;
6. a proposed alteration that would have negligible adverse physical or biological impact on wetland resources.

If mitigation is not waived the most appropriate method of mitigation will be incorporated into the final permit. The following rules will be used when applying mitigation to proposed alterations of wetlands:

1. No proposal for mitigation may be inconsistent with any part of South Carolina's coastal zone management plan for the area where the dredge and fill, environmentally

destructive activity, or the proposed mitigation will occur.

2. Mitigation should occur in the same drainage as the alteration under consideration. On-site mitigation is preferred; however, if mitigation on-site is deemed infeasible or ineffective, a more appropriate site for mitigation may be selected.
3. In-kind mitigation is required whenever possible. If in-kind mitigation is deemed infeasible, alternative mitigation (as set forth in "Specific Mitigative Strategies") shall be required.
4. Dredge and fill operations shall be mitigated by creation, restoration, or enhancement of wetlands with directives for maintaining the biological and functional characteristics and processes of the impacted site(s).
5. Mitigation by creation of wetlands shall consist of grading down a suitable area of highland to elevations susceptible to regular tidal flooding. Planting of appropriate wetland vegetation may be imposed.
6. Mitigation by restoration or enhancement may include but is not limited to:
  - a. physical improvement in areas where poor water quality limits fish and shellfish production and harvest or human recreation;
  - b. lowering "dredge" spoil islands to create or restore intertidal surface areas;
  - c. breaching of diked marshes for improved circulation and flushing;
  - d. removal of unused pile structures, pilings, and debris.
7. The agencies may require an area of mitigation two times the area affected by the proposed wetlands alteration. A ratio of at least one acre of mitigation for one acre of destroyed habitat shall be required. Mitigation shall in no



instance create, restore, or enhance wetlands and resources of an area smaller than the area affected (to include the actual area under development and the adjacent wetlands adversely affected by the activity).

8. Mitigative sites and activities need not be fully developed biologically at the time of acceptance by the regulating agencies, but the mitigative activities must have been fully implemented and evaluated by the lead agency and must display a high probability of success.
9. Wetland developments that are not "dredge and fill" operations may be mitigated by following guidelines outlined in "Specific Mitigative Strategies."

B. Agency Responsibility

1. In reviewing a permit for wetlands alteration, the review agencies shall specify (if appropriate) the requirements for mitigation as a permit condition. Measures for mitigation along with other recommendations will be received by the permitting authorities for final action.
2. The final joint application for a permit involving mitigation shall provide the review agencies with additional information addressing the following points:
  - a. a specific proposal for mitigation for the proposed development project;
  - b. A map of the location and the plan(s) for the proposed site(s) for mitigation showing elevations and resource-habitat types;
  - c. a proposed plan for mitigation at a specific site and the projected biological productivity of the resources.
3. In reviewing a joint permit application involving mitigation, the review agencies shall determine:
  - a. the adverse impact of the proposed activity;
  - b. the extent of potential compensating features inherent in the proposed activity;

- c. the availability of areas in which mitigating activities could be undertaken;
  - d. how and to what extent wetlands will be created, restored, or enhanced, and how the mitigated site will retain the biological processes of the altered wetlands or to what extent alternative mitigation will compensate for lost public usage of resources.
- 4. The review agencies may adjust the relative value of any type of habitat affected by development in wetlands if the conditions and characteristics of the site (pollution or very high resource value) warrant such adjustments.
  - 5. The review agencies will administer on-site post-project inspections of projects involving mitigation to insure compliance with permit conditions and to evaluate the overall effectiveness/success of the required mitigation. Information generated will be received by the permitting authorities for enforcement actions if applicable.

### III. GENERAL GUIDELINES FOR ACTIVITIES RELATED TO OIL, GAS AND MINERAL DEVELOPMENT AND PRODUCTION

#### A. Introduction

To meet increasing national demands for energy and other resources, petroleum, gas, coal, and other mineral developments will intensify in the coastal zone and the OCS of the United States as these resources become technologically available. Speculation by the petroleum industry in 1974 suggested that by 1985 20 percent of oil and 30 percent of gas production will come from offshore developments. State-controlled bottoms (within the three mile territorial seas limit) have potential for oil and gas production but their anticipated percentage of domestic production is much less significant than the OCS due to local environmental opposition to development (Kash, 1974).

Until recently, decisions to develop have been made primarily on the basis of two criteria: 1) whether it was

technically feasible, and 2) whether it would be commercially profitable. Social desirability has generally been in terms of promise to produce immediate, tangible social benefit. Critics blame inadequate technological decisions for environmental degradation and a variety of undesirable social impacts.

The present Federal administration has adopted a policy to accelerate the development of oil and gas on the OCS. With this in mind, both Federal and state governments share the responsibility of evaluating the potential environmental, legal, political and social impacts created by the oil and gas development industry and of allowing development in such a manner that the least possible disruption of natural land formations, water flows, or fish and wildlife habitat and resources will occur. The first response to the recent concern with OCS development was imposition of stricter operating standards by the United States Geological Survey (USGS).

The Supreme Court (1975) mandated the Federal government responsible for coordination on the OCS beyond three miles seaward. Under the Submerged Lands Act (SLA) of 1953, title to the seabed within three miles was vested in the Atlantic, Pacific, and Gulf states (except for the west coast of Florida and Texas whose limits extent to 10.25 miles). Under the Outer Continental Shelf Land Act (OCSLA) of 1953, the Secretary of Interior has the authority to issue leases for resource development.

Upon consideration of a tract for leasing, the Mineral Management Service (MMS) of the USGS is directed to prepare a summary report describing the geological potential and evaluating the tract value. The MMS prepares leasing maps, announces schedules of lease sales, and evaluates potential effects of exploration and production on the environment. The MMS may also hold public hearings and consult with appropriate state and Federal agencies, organizations, industries, and individuals.

The USGS is responsible for maximizing economic recovery while minimizing environmental damage. It may suspend an operation which in its judgment threatens immediate, serious or irreparable harm or damage to life, property, leased deposits, other valuable mineral deposits, or the environment. Additionally, the MMS grants pipeline rights-of-way for oil and gas transportation while USGS grants easements to construct and maintain pipelines on areas controlled by lessees. In addition, the USGS approves the design and installation plans of fixed structures on the OCS, while the U.S. Coast Guard (USCG) promulgates and enforces rules which promote human and environmental safety in operations related to such structures. Pollution of water, land, or aquatic life is determined by USGS who has the authority to have the pollutant removed at the lessee's expense. Continuance or extension of any lease depends on compliance with these regulations (Mangone and Homer, 1975).

The National Oil and Hazardous Substances Pollution Contingency Plan, a segment of the FWPCA, establishes a framework for coordinated, integrated response by Federal agencies including EPA, Interior (USGS), Transportation (USCG), and Defense. The industry has responded by developing several regional clean-up cooperatives maintaining clean-up equipment and trained personnel.

The NEPA requires that an Environmental Impact Statement (EIS) be completed prior to any bottom exploration. Baseline investigations should be extensive enough to permit an analysis of the potentially impacted area as an ecosystem. At this time, performance standards are established by USGS and the preparation of data, information and the evolving manuscript is the responsibility of the MMS. Many other entities including local, state and Federal governments, industry, environmental representatives, and private interest groups, provide comments and requests to MMS for various alterations, stipulations, and

exclusions. Public hearings on EIS's and the opportunity to make written comments give citizens, local, state and Federal agencies, and private interest groups a chance to express their concerns about proposed oil and gas development.

The South Carolina Oil & Gas Act (Act 179 of 1977) authorizes the SCWRC to regulate drilling activities for oil and gas on all lands, including submerged lands within the jurisdictional limits of South Carolina. This does not supercede or take precedence over SCDHEC's Section 401 water quality certification responsibilities. The SCWRC has the authority to issue permits for drilling and to regulate all activities associated with drilling and production. Accordingly, the SCWRC has established rules and regulations which further define statutory authority (1976 South Carolina Code of Laws, as amended, Section 48-43-10 et seq.).

B. General Guidelines

In the absence of knowing the overall impacts, OCS oil and gas operations should be conducted to produce minimum change. Standards for performance and suggestions for minimizing impacts should be written to allow flexibility for alternative solutions and continuing improvements.

Development of oil and gas on the OCS and other kinds of coastal energy activity require many onshore support facilities (e.g., ports, pipelines, refineries). These activities, including the transportation, transfer, conversion or storage of natural gas, oil, coal, or other energy resources will most probably occur within the geographic jurisdiction of South Carolina. The inter-relationships between OCS activity and resulting onshore impacts are inseparable and, therefore, warrant concern by various state governmental units and public interest groups. Recent studies indicate that existing state coastal zone management programs would provide the most effective vehicle for planning changes brought about by OCS development (Mangone and Homer, 1975).

To determine whether existing South Carolina coastal regulatory policies are addressed in a proposed energy related project (both onshore and OCS), the following information should be submitted as part of the permit application to the state for all projects that may impact, change or influence the coastal zone of South Carolina:

1. A plot of the entire area under lease or ownership, showing the relationship of proposed facilities to ultimate potential development;
2. A topographic map in sufficient detail showing the relationship of proposed facilities to other buildings, structures, and/or natural or artificial features, including sensitive habitats, prime agricultural lands, recreational areas, scenic resources and archaeologically sensitive areas within 1,000 feet of the facility;
3. A plan for the consolidation of facilities;
4. A phasing plan for the staging development which indicates the anticipated timetable for project installation, completion, and decommissioning;
5. A plan for eliminating or substantially mitigating adverse impacts on habitat area, prime agricultural lands, recreational areas, scenic resources, archaeologically sensitive sites and neighboring residents due to siting, construction, or operation of facilities;
6. Plans and profiles of any major grading required for construction and production of the facility showing pre-project and post-project elevations and the amount and location of fill needed;
7. An analysis of the visibility of proposed facilities from offsite public viewing areas and a landscape plan to minimize this visibility. Such landscape plans should include the methods to be used for screening energy facilities, such as erecting fences, planting vegetation, using depressions below grade, or other techniques;

8. A summary description of the procedures for the transport and disposal of all solid and liquid wastes;
9. A description of fire prevention procedures;
10. Evidence of compliance with applicable air quality regulations;
11. Local infra-structure, such as water, sewer, fire protection, and road capacity, required to service project needs;
12. Procedures for the abandonment and restoration of the site which shall indicate restored contours of the land, top-soil replacement and revegetation upon abandonment, unless abandonment-in-place is determined to be less environmentally damaging.

(California Coastal Commission, 1981.)

Considering the uncertainty of future energy and industrial development plans in South Carolina, it is appropriate that a priority system be established to provide a mechanism for establishing strategies for mitigation. With these priorities in use, prospective developers may more properly analyze and process their plans for energy development. In addition, this system may be used as a tool by state environmental agencies to designate particular land areas and wetlands for development related to energy production. Alternative sites shall be rated according to the following priorities:

Priority 1 Sites: Sites with existing facilities suitable, with minor alterations, to accommodate the proposed use or that could accommodate the proposed use through expansion.

Priority 2 Sites: Sites requiring the construction of new facilities which do not convert wetlands. Preferred sites within this category are those requiring the least site alteration (e.g., dredging, grading, habitat modification).

Priority 3 Sites: Sites where the proposed use would require conversion of wetlands.

Priority 4 Sites: Sites requiring conversion of wetlands and dredging of a new deep-water channel.

The proposed use shall be located on a site with the lowest priority rating (i.e., Priority 1 is the lowest). A Priority 3 or 4 site shall be used only if 1) the proposed use cannot feasibly be accommodated in a Priority 1 or 2 site, 2) use of Priority 1 or 2 sites would be more environmentally damaging or would adversely affect the public welfare, or 3) adverse environmental effects are mitigated to the maximum extent feasible.

C. General Stipulations for Inshore and OCS Activities

The developer must prepare acceptable pre-impact biological evaluation and assessment reports for all major developments that may adversely affect the state's wetlands or wetland resources. This evaluation will establish the biological resources potentially affected and their relative value.

It will be the responsibility of the developing interest to schedule routine biological and water flow pattern monitoring of the ecosystem surrounding the various development sites (drilling site, pipeline corridor, access roads, canals and waterways, shipping channels, etc.) to encourage early detection of impacts. Constant routine documentation of seepage and spillage should be undertaken and coordinated with documentation of onsite impacts to vegetation, wildlife and wetlands flow patterns. If significant reduction of biological resources is recognized during routine biological monitoring the "pre-impact biological evaluation" will be utilized as an index with which to establish lost resource value and prescribe appropriate mitigative strategies.

A well rehearsed oil spill cleanup plan should be a prerequisite to drilling. Adequate cleanup equipment and personnel should be maintained at each drill site.

It will be the responsibility of the developer to present proof that contamination of offshore aquifers and potential



future destruction of habitat due to geologic hazards, has not and will not occur.

#### IV. SPECIFIC MITIGATIVE STRATEGIES

##### A. Mitigative Strategies for OCS Oil and Gas Related Activities

###### 1. Impacts

Loss of bottom habitats and resources due to substrate removal and displacement result from seismic measurement by detonation, construction of exploration and production platforms and auxiliary facilities (pump stations and cleaning stations) and pipeline installation on the bottom surface or substrate. (Palmer, 1948; Landes, 1959; Conner et al., 1976; Clark et al., 1978; Querrieri, 1982)

Additional impacts to habitats and resources could result from discharges due to exploratory drilling, accidental blowout, platform collapse, collision of vessels with platforms, seepage, production pumping, washing, sewage pipeline leakage and spillage, and possible natural seismic activity. These discharges introduce potentially toxic material into aquatic environments and increase turbidity and sedimentation. Discharges of muds and cuttings result in destruction of marine habitats and displacement of resources due to sedimentation and toxic effects. (Bellinger, 1972; Perkins, 1974; Zingula, 1975; Conner et al., 1976; Gilmor et al., 1981; Drucker, 1982; E. E. & G. Environmental Consultants, 1982; Popenoe et al., 1982; Querrieri, 1982)

Oil and gas development activities can create potentially hazardous obstacles in open water including flotation pipelines, submerged pipelines, docks, piers, production and separation facilities. Commercial and recreational interests may conflict with these potential hazards. Displacement of wildlife resources due to noise and activity is also apparent. (Querrieri, 1982)

###### 2. Minimization of Environmental Impacts

- a. During exploratory activity, vibration and gravity measurement techniques for survey should be used where possible since they generate significantly fewer environmental impacts.
- b. All shotholes should be adequately refilled.
- c. Sites, pipelines, and other activities should be located to avoid areas of concentrated marine life.
- d. Directional drilling should be utilized whenever possible and environmentally desirable.
- e. Impacted areas should be minimized by restricting all activities and required easements (right-of-way) to the width of the pipeline, excepting minimal expansion for supportive equipment and facilities.
- f. Storage of muds and cuttings should be encouraged and unchecked ocean disposal should be forbidden.
- g. Alternatives to on-site discharging of water-based drilling mud and cuttings may include:
  - 1) transporting by vessel to an authorized land or ocean dump site;
  - 2) use of a Single Point Mooring buoy to facilitate transfer of the mud/cuttings from the drilling rig to the transporting vessel in lieu of pumping directly from the drilling rig;
  - 3) use of a pipeline from the drilling rig to transport the mud/cuttings to a distant authorized ocean dump site;
  - 4) shunting, dilution, incineration, recycling, injection, or reuse;
- h. Maintenance dredging and construction should be coordinated with periods of least wildlife activity and concentration.
- i. Sound baffling techniques and noise barriers for noise producing machinery should be provided.

- j. Appropriate safety precautions (lights, signs, barriers), for all water-borne vehicles and obstacles should be provided.

### 3. Mitigation Alternatives

Although unavoidable impacts to the ocean floor may be relatively minor, mitigation or replacement of lost habitat is appropriate. Alternatives may include:

- a. Replacement of fish habitat by creation and maintenance of artificial reefs and other fishery enhancement programs distributed in the proximity of the well platform, pipeline, or detonation impact area;
- b. Construction and maintenance of specialized spawning habitat for impacted species that are commercially or recreationally important;
- c. Establishment of bonds structured for ecological and fishery research oriented projects, for aquaculture-mariculture operations focused on resource replacement of impacted species, and granting of funds, derived from severance taxes imposed on production, to state environmental agencies. Specify funds to be used for environmental enhancement and restoration;
- d. Establishment of state fishermen contingency funds to compensate for lost revenues and equipment from competing energy and mining interests.

## B. Mitigative Strategies for Inshore Oil and Gas Related Activities

### 1. Impacts

Impacts include loss of subtidal or intertidal habitats and resources due to filling for facility siting; dredging for construction of docks, transmission stations, and auxiliary facilities (pump and cleaning stations); filling for access roads; excavation of canals intended for exploration; drill site preparation; and pipeline

installation. Habitat loss may be in the form of crushed vegetation, roads rutted by vehicular traffic, or cleared areas. Secondary impacts resulting from bank erosion due to increased construction and maintenance traffic result in a general displacement of various plant and animal species adjacent to the construction sites, access roads, pipeline installations and all rights-of-way for the duration of continued maintenance. Additional impacts include potential formation of impervious layers of drilling muds, potential release of toxic and/or noxious substances from road surfacing material, accidental spillage, pipeline rupture and chronic leakage, washing and working of drilling equipment and support equipment. (McGinnis et al., 1972; Conner et al., 1976; Swanson, 1979; Querrieri, 1982)

Further loss of organisms occurs as a result of increased turbidity, sedimentation, oxygen depletion from high organic debris levels, and reduced circulation and salinity. Alteration and/or destruction of biological habitats due to discharge of noxious waste (including water and brine from separation facilities) are also significant impacts.

## 2. Minimization of Environmental Impacts

- a. During exploratory activity, vibration and gravity techniques for survey should be used where possible. Gravity measurements provide less detailed subsurface information than a seismic survey but generate significantly fewer environmental impacts.
- b. Existing roads should be used whenever possible.
- c. New roads and construction sites should be aligned to avoid sensitive wildlife areas.
- d. Impacted areas should be minimized by restricting all activities and required easements (rights-of-way) to the width of the pipeline, excepting minimal expansion for supportive equipment and facilities.

- e. The least toxic road surfacing material should be utilized. On-site porous, indigenous materials (shell, gravel, crushed marl) are preferred.
- f. Vegetation on rights-of-ways should be cut; herbicides should not be used.
- g. Surface drainage should not be blocked or altered.
- h. Adequate bridges, culverts, and bulkheads should be installed to maintain existing waterflows and prevent erosion.
- i. Temporary alterations of waterflows as a result of spanning waterways should be returned to normal flow patterns.
- j. Well sites should be located to avoid sensitive wildlife and vegetation.
- k. Directional drilling should be utilized whenever possible and environmentally desirable.
- l. "Double-ditching" for pipeline installation (topsoil and vegetation removed first, replaced last), should be utilized with backfill occurring as soon as the pipe is laid in order to avoid spoil shrinkage (drying).
- m. Plugs (used when pipelines cross open water) and riprap should be designed to withstand all abuses to the pipeline depending on land uses.
- n. Pipeline placement in coastal waters should avoid anchorage areas and should be reported to charting agencies.
- o. Boat traffic should be minimized and rates of speed lowered in sensitive and/or altered areas to reduce erosion. Areas of erosion may be reinforced with riprap or erosion resistant fabric.
- p. In general, the use of exploratory, drilling and pipeline installation equipment requiring the construction of canals (dredge and spoil) should be discouraged while the utilization of specialized

equipment designed to minimize wetland impacts should be encouraged.

- q. Rutted roadbeds and shot sites should be filled and revegetated to preexploration standards; these sites should be monitored for natural revegetation to assure complete revegetation within two (2) growing seasons.
- r. All drill cuttings, muds and other waste not being reused should be placed in proper containers and moved for appropriate disposal or injections (see section A.2).
- s. In general, a no-discharge policy in wetlands should be maintained, including brine and/or freshwater.
- t. Placement of production and separation facilities on upland locations should be encouraged.
- u. All drilling sites, production sites, separation facilities and pumping stations located in or near wetlands should have adequate lined retaining structures including pits or levees. Ring levees should be reduced in size to accommodate only the equipment and access corridors.
- v. Potentially hazardous supplies should be stored in impervious containers or lined pits. All holding pits should be adequately lined and maintained.
- w. The most up-to-date technology and equipment to completely skim oil from wash, soap waters, and separation waters should be utilized. Faulty or leaking equipment should be replaced.
- x. Construction upland should be revegetated and landscaped to provide an aesthetic vista, incorporating drilling platforms, support buildings and storage facilities into the most natural and pleasing environmental setting.

### 3. Mitigation Alternatives

- a. All wetland habitat lost to filled access routes or areas permanently or adversely altered on a long-term basis should be mitigated by creation, restoration and enhancement of wetland habitat accomplished in a manner prescribed by the agencies.
- b. All wetland habitat lost to excavation as a result of well site and canal construction, dock construction, and transmission or utility stations should be mitigated by creation, restoration or enhancement of wetland habitat accomplished in a manner prescribed by the agencies.
- c. All laying of pipe (other than floating and submerged pipelines) will be considered a dredge and fill operation and will be mitigated by creation, restoration, or enhancement of wetland habitat in a manner prescribed by the agencies.
- d. Surrounding wetland areas that are marginally productive or otherwise stressed should be restored or enhanced by grading and revegetation or providing channels or corridors to increase water exchange and nutrient flow.
- e. Damages or alterations to the environment as a result of temporary but highly destructive changes in waterflows, due to spanning waterways, will be evaluated and mitigation recommended according to resource losses and duration of impacts. Depending on the severity of the impacts on the environment and the period of altered waterflow, mitigation alternatives may include those listed below:
  - 1) mitigation of erosion by creation, restoration, or enhancement of wetlands;
  - 2) revegetation or enhancement of banks or existing marginal habitat on-site or off-site (both must be in-kind);

- 3) establishment of value for lost resources and levying of compensatory fees;
  - 4) creation and maintenance of public shellfish grounds;
  - 5) creation of shorebird nesting habitat;
  - 6) creation and maintenance of fishery enhancement program.
- f. Mitigation for short-term destruction of habitat and wildlife resources due to turbidity and toxic pollutants (due to accidental spillage or seepage, etc.), sedimentation, and oxygen depletion, shall be accomplished in a form acceptable to the agencies, and may include:
- 1) creation of circulation cuts to by-pass potentially polluted waters and provide alternative access for wildlife and water flows;
  - 2) construction and maintenance of public use facilities (docks, piers, marinas, boat ramps, waterfront parks, etc.);
  - 3) development of fishery enhancement programs including: artificial fishing reefs, aquaculture programs, construction of specialized spawning habitat, and construction and maintenance of public shellfish grounds;
  - 4) restoration or enhancement of marginal wetlands habitat;
  - 5) establishment of bonds structured to support research on the ecology of wetlands or wetlands creation technology.



C. Mitigative Strategies for OCS and Inshore Minerals Related Activities

1. Impacts

Substrate impacts include excavation and/or stripping of wetlands or sea floor during mining operation, bottom disturbances by platforms and/or anchors, etc. Excavations may also be necessary for the construction of slurry pipelines and/or conveyors from port or mining site to the processing plant location. Small scale mining of beach material for beach restoration may contribute to coastal erosion. Increased turbidity and chemical shifts due to mechanical resuspension of sediments caused by gathering and draining of materials as well as increased turbidity and sedimentation as a result of drilling muds and cuttings (coal, etc.) and other excavation operations, result in mortality of benthic organisms. Other impacts include potential toxic effects from chemical wastes from shoreside or mining site mineral processing including hydrous slimes, settleable sludges, ash, scrubber solids, and lime boil solids. Toxic effects result from accidental rupture or leakage from slurry pipelines or transfer lines to transport vessels. Increases in the elevation of the ocean floor (from excavation and tailings disposal) affect wave diffraction and sediment transport patterns thus affecting marine life habitation.

2. Minimization of Environmental Impacts

- a. Unavoidable impacts resulting from offshore and near shore excavation for minerals can be minimized by avoiding spawning or nursery grounds or otherwise ecologically sensitive areas.
- b. Mining in or near areas of significant commercial and recreational fisheries and shellfish resources should be discouraged.
- c. Slurry pipelines should be restricted to pipeline corridors.

- d. Solution mining should be utilized whenever practical (coal and copper/nickel sulfide mining only).
- e. All mining and dredging should follow natural bottom contours to avoid the creation of steep slopes and excavations.
- f. Enough of the original substrate surface should be left to support recolonization by the original communities.
- g. Bottom areas with polluted sediment should be closed to dredging and mining.
- h. Dredging in areas occupied by cable, pipeline, or sewage crossings and outfalls should be prohibited.
- i. On-site processing, washing and disposal inherent in mineral processing should be discouraged.
- j. Transporting (pipeline or vessel) of mined/dredged materials away from the mining site should be encouraged.
- k. The use of temporary retaining walls around the mining/dredging site to contain suspended sediments should be encouraged.
- l. The usage of land dump sites over potential ocean dump sites should be encouraged. Transporting non-toxic processing wastes to the mine site for injection into deep excavations should be encouraged.
- m. Slurry water (fresh or salt) should be recycled or treated before being returned to land or sea.
- n. Depending on types and quantities of wastes, the following processes should be implemented:
  - 1) Precipitation of soluble toxic elements from direct discharge or treated wastes;
  - 2) Precipitation of soluble toxic elements followed by washing of solid waste to remove

soluble innocuous and toxic elements for separate discharge;

- 3) Precipitation of soluble toxic elements followed by washing to remove remaining solids and drying of solid wastes for disposal.
- o. Storage of waste materials in cases where further processing may produce additional mineral products should be encouraged.
- p. Burial of dry or nearly dry waste in landfills or use of waste material as cover material in municipal sanitary landfill should be encouraged.
- q. OCS aggregate mining in coastal areas shallower than 80 feet (the natural equilibrium of sandy beaches is maintained within this contour) should be discouraged.

### 3. Mitigation Alternatives

- a. All dredge and fill operations resulting in loss of wetlands or coastal bottoms will be mitigated by creation, restoration, or enhancement of wetland habitat as appropriate and approved by the agencies.
- b. Significant decrease in resource value or potential shall be mitigated in a manner acceptable to the agencies and may include:
  - 1) Utilization of resource values and potentials established in the environmental impact statement to set compensatory fees.
  - 2) Establishment of funding for research and development of fishery enhancement programs that may include:
    - a) aquaculture and replenishment of lost fish and wildlife stocks;
    - b) implementation, maintenance and research of artificial reefs.
  - 3) Establishment and maintenance of state fishermen contingency funds.

## REFERENCES CITED

Ashe, D. M. 1982. Fish and wildlife mitigation: description and analysis of estuarine applications. *Coastal Zone Management Journal* 10(1/2):1-51.

Banner, A. 1979. Mitigation under the Corps' regulatory program. *IN* G. A. Swanson. The mitigation symposium. Col. State Univ., Fort Collins, Colorado. USDA General Technical Report RM-65.

Bellinger, G. A. 1972. Historical and recent seismic activity in South Carolina. *Bull. Seis. Soc. Am.* 62(3): 851-864.

Brunner, K. 1980. U.S. Army Corps of Engineers. Seattle District, Personal Communication. *IN* Ashe, 1982.

California Coastal Commission. 1981. Coastal energy development: the California experience. A Guide for Coastal Local Governments. 133 pp.

Clark, J., J. Zinn, and C. Terrell. 1978. Environmental planning for offshore oil and gas. Vol. I, Recovery Technology. The Conservation Foundation, Washington, D.C. U.S. Fish and Wildl. Serv., Biol. Serv. Prog. FWS/OBS-77/12. 226 pp.

Conner, W. H., et al., 1976. Oil & gas use characterization, impacts, and guidelines. Sea Grant Publication No. LSU-T-76-006. 148 pp.

Drucker, B. S. 1982. Geologic hazards & constraints to oil & gas operations on the U.S. Outer Continental Margin, An Overview. MMS, DOD, Tech. Paper 82-02. 84 pp.

E. E. & G. Environmental Consultants. 1982. A study of environmental effects of exploratory drilling on the Mid-Atlantic Outer Continental Shelf. Final Report of the Block 684 Monitoring Program. Prepared for Offshore Operators Committee of Exxon Production Research Company. 88 pp.

Gillmor, et al. 1981. Effects of exploratory drilling discharges on the benthic environment in the middle Atlantic OCS: Biological results of a one-year post-drilling survey. *IN* Proceeding of the third international ocean disposal symposium. Woods Hole Oceanographic Institute, MA.

Kash, P. E. 1974. Energy under the oceans, a technology assessment of outer continental shelf oil and gas operations. Univ. of Oklahoma Press, Norman, Oklahoma. 378 pp.

Krulitz, K.M. 1979. Federal legal background for mitigation. Keynote Address, pp. 19-26 *IN* G. A. Swanson. The mitigation symposium. Col. State Univ., Fort Collins, Colorado. USDA General Technical Report RM-65.

Landes, K. K. 1959. Petroleum geology. John Wiley and Sons, New York, New York.

Lindal, W. N., Jr. et al. 1979. Estuarine habitat mitigation planning in the Southeast. pp. 129-135. IN The mitigation symposium: A national workshop on mitigating losses of fish & wildlife habitats. GTR-RM-65.

Lindsey, J. 1983. Personal Communication. Director, Louisiana Department of Environmental Affairs, Louisiana Department of Natural Resources, Baton Rouge, La.

Mangone, G. J. and J. Homer 1975. Decisions for Delaware: Sea Grant looks at legal aspects of OCS development. Center for the Study of Marine Policy, College of Marine Science, Univ. of Delaware, DEL-SG-1-75(2). 24 pp.

McGinnis et al. 1972. Final report on environmental aspects of gas pipeline operations in the Louisiana coastal marshes. Battelle-Columbus Labs.

Palmer, R. P. 1948. Techniques and problems in marine seismic exploration. Oil and Gas J. 47:160-168.

Perkins, E. J. 1974. The biology of estuaries and coastal waters. Academic Press, New York, New York.

Popenoe, P., E. L. Coward, and K. V. Cashman. 1982. A regional assessment of potential environmental hazards to and limitations on petroleum development of the southeastern U.S. Atlantic shelf, slope, and rise, offshore N.C.: U.S.G.S. Open-file Report 82-136. 67 pp. plus map.

Power, G. 1973. The fox in the chicken coop. The regulatory program of the U.S. Army Corps of Engineers. Virginia Law Review 63(4):503-504.

Querrieri, U. 1982. Fate of drilling discharges in the marine environment. Marine Board, National Academy of Sciences. Working paper #2. 30 pp.

Setchfield, H. 1983. Personal Communication. Florida Department of Environmental Regulation, Tallahassee, Fla.

Smith, S. E. 1983. An Oregon mitigation primer. Draft: January, 1983. Columbia River Estuary Study Taskforce, Astoria, Oregon. 29 pp.

Zingula, R. P. 1975. Effects of drilling operations on the marine environment. p. 443-450. IN Conference proceeding on environmental aspects of chemical use in well drilling operations. EPA-55011/75-004.

40 992620

---

